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Timing of grey seal pupping on Hay Island

Période de mise bas chez les phoques gris de l'île Hay

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ABSTRACT

The temporal distribution of births on Hay Island was examined using two approaches. One model assumed that births followed a normal distribution and used the change in the proportion of pups in 3 identifiable age-dependent stage classes as the season advances to develop the birthing ogive. The second approach assumes that the birth rate in a year can be adequately described by a continuous function of time. Animals pass through a series of 5 identifiable age-dependent stages of which the duration can be described by a semi-Markov process, *i.e.*, the transition intensities depend only on the current stage and the time so far spent in that stage. The Normal model estimated that 90% of the young of the year on the island are estimated to be weaned by 9 February (se=1.7) and have reached the beater stage by 15 February (se=3.1). This was slightly later than the 5 stage-model which estimated that 90% of the animals had reached the beater stage by 11-12 February. The timing of pupping, weaning, when animals reached the beater stage and when they might disperse were examined together. The available information suggest that a harvest on or shortly after 9 February would encounter few adults still lactating, but a large proportion of beaters would be present and few beaters would have dispersed from the breeding colony.

RÉSUMÉ

On a adopté deux approches pour examiner la distribution temporelle des naissances à l'île Hay. Dans un modèle, on a supposé que les naissances suivent une distribution normale et, pour élaborer la courbe des naissances, on a utilisé la variation de la proportion de nouveau-nés à trois stades de développement liés à l'âge identifiables à mesure que la saison avance. Dans la deuxième approche, on a supposé que le taux des naissances au cours d'une année peut être adéquatement décrit par une fonction de temps continue. Les animaux passent par une série de cinq stades identifiables liés à l'âge dont la durée peut être décrite à l'aide d'un processus semi-Markov où l'intensité de la transition dépend seulement du stade actuel et de la période déjà écoulée pendant ce stade. Le modèle normal estimait que 90 % des jeunes de l'année présents dans l'île étaient sevrés au plus tard le 9 février (se = 1,7) et avaient atteint le stade de brasseurs au plus tard le 15 février (se = 3,1). Ces dates étaient légèrement plus tardives que dans le modèle à cinq stades où 90 % des animaux avaient atteint le stade de brasseurs au plus tard le 11 ou le 12 février. Le moment de la mise bas, du sevrage, de l'atteinte du stade de brasseur et de la dispersion éventuelle a été examiné globalement. Les renseignements disponibles indiquent qu'une chasse menée le 9 février ou peu après cette date rencontrerait peu d'adultes allaitant encore leurs petits, mais qu'une grande partie des brasseurs serait encore présente car un petit nombre d'entre eux seulement se serait éloigné de la colonie.

INTRODUCTION

The breeding population of Northwest Atlantic grey seals is divided into three components for management purposes, based on the locations of the breeding colonies. These are the Sable Island component, the Gulf of St. Lawrence and the Eastern Shore (Fig. 1) (Thomas et al. 2007). Sable Island is the largest of the three components accounting for about 85% of total pup production. The Gulf component comprises animals that whelp primarily on the drifting pack ice in Northumberland Strait and those born on small islands located within the southern Gulf of St. Lawrence. The third region, the Eastern shore of Nova Scotia, is by far the smallest part of the population. It comprises seals that whelp primarily on Hay Island, but also includes some other small islands along the eastern shore of Nova Scotia including Bowen's Ledge, White Island, Flat and Noddy Islands (Hammill et al. 2007). These islands have been monitored intermittently by visual counts or year-class tagging. All three regions were surveyed most recently in spring 2007 (Bowen et al. 2007; Hammill et al. 2007).

Non-Sable Island grey seals begin pupping on the islands in December and births continue until early February. There are distinct differences in the timing of pupping among the three components, with the peak of births on Sable Island occurring in early January (Bowen et al. 2007). In the Gulf, 50% of the pupping on the ice appears to be complete by about the third week in January, whereas on the islands in the Gulf 50% of births have occurred by 11 January. On Hay Island, 50% of births occur by mid- January.

The Hay Island colony is the largest of the island colonies along the Eastern shore (Hammill et al. 2007). It is a relatively recent colony, first discovered during the early1990s during a DFO helicopter patrol (J. Conway, pers. comm.). The most recent estimate (i.e., 2007) of pup production on the island is 2700 animals (Hammill et al. 2007). The Hay Island colony is located close to shore and is relatively easy to access, thus making this colony of interest for harvesting. The so-called beater stage, which is a weaned young of the year (YOY) that has fully moulted the white birth pelage (termed lanugo), is the primary target for the commercial hunt. Visiting the island too early will result in few beaters being available for harvest, and would also mean that large numbers of mother-pup pairs would still be present. Disturbance may cause pup abandonment or force hunters to spend time defending themselves from aggressive adults. Visiting the island too late, after all pups have been weaned, may reduce yield as many YOY would have left the island. The purpose of this document is to provide information on the timing of births and weaning on the island to assist in making decisions on when to undertake the harvest.

MATERIALS AND METHODS

Several surveys have been completed on the island to determine abundance (1996, 1997, 2000, 2004, and 2007; Thomas et al. 2007), but sufficient data to determine the timing of births has only been collected in 2000, 2007 and 2008.

Hay Island was visited and during ground surveys, pups were assigned to one of 5 distinct age-related categories based on a combination of morphometric and pelage features to model the distribution of births (Bowen *et al.* 2003):

Stage 1. Newborns still wet with birth fluids, pelage yellowish tint, skin in loose folds, locomotion awkward, (Mean duration=3.0, SE=0.64);

Stage 2. Neck well defined, trunk of body cylindrical in shape, pelage white; (Mean duration=3.0, SE=0.65)

Stage 3. Neck and trunk of body combine to produce a fusiform shape, pelage white to light grey; (Mean duration=11.8, SE=2.53).

Stage 4. Lanugo being shed from any part of the body, excepting the face (Mean duration=7.6, SE=1.98).

Stage 5. Lanugo completely shed exposing the underlying juvenile pelage or isolated tufts of lanugo <5 cm diameter still present. (Age=25 days, cv set at 10%, se=2.5).

The estimates of stage durations in parenthesis above are derived from a studied on Sable Island in which the pelage stage of individually marked pups is scored every day from birth until they have complete shed their lanugo (Bowen et al. 2007).

Hay Island was surveyed repeatedly and the change in the proportion of pups in each of the age-dependent categories was recorded (Table 1). Two models were used to model the distribution of births. One model assumed that births followed a Normal distribution and used the change in the proportion of pups in 3 different stage classes as the season advances to develop the birthing ogive (details described in Stenson *et al.* 2003). We also fit the Bowen McMillan and Blanchard (2007) model to the Hay Island pup birthing distribution using the 2007 Sable island stage-duration data. This approach assumes that the birth rate in a year can be adequately described by a continuous function of time. Animals pass through a series of 5 identifiable age-dependant stages of which the duration can be described by a semi-Markov process, *i.e.*, the transition intensities depend only on the current stage and the time so far spent in that stage. Due to numerical difficulties with convergence only the Weibull model estimates are reported. The start of pupping was not known for Hay Island with certainty, therefore a sensitivity analysis was performed using starting dates between December 20, 2006 and December 31, 2006.

The stage models provided information on the timing of births. Lactation length in grey seals is variable. Noren et al. (2008) estimated a mean duration of 19 ±0.2 days (range 16-22 days). The YOY shed the lanugo to become beaters which occurs at the age of approximately 25 days. After weaning, the YOY fast onshore for a period of days then begin entering the water and disperse to feed. On Sable Island, time to dispersal averaged 40 ±1.1 (mean±se) days, but was also quite variable (range 26-49 days).

RESULTS

There is some variability between years in the timing of births, but the 3-stage Normal model estimated that 50% of births had occurred by 6 January in 2000 (se=2.4), 13 January in 2007 (se=1.3) and 9 January in 2008 (se=0.8) (Fig. 2). Pooling the three years resulted in an estimate of 50% of the births occurring by 10 January (se=1.9). Virtually all births are complete by 24 January (se=1.8). Births ended earlier in 2000 (19 January, se=4.5), compared to 2007 (26 January, se=2.0).

Using the pooled data only, 50% of the young are estimated to be weaned by 29 January (se=1.9)(Fig 3). Nursing animals are still observed in February, but the estimated proportion of animals suckling (1- the proportion weaned), will decline to 10% by 9 February (se=1.7)(Fig 3).

Near the end of lactation, the pups begin to moult. The first beaters are estimated to appear by late January (10% beaters: 24 January, se=3.5). By 15 February (se=3.1), 90% of the YOY on the island are estimated to have reached the beater stage (Fig. 3). YOY are estimated to begin leaving the island by 8 February (se=2.6), with almost all animals having left by 4 March (Fig 3). No YOY have been observed hauled out during visits to the island in early March.

Table 2 gives the assumed starting date of pupping on Hay Island, the Weibull distribution parameters, the log-likelihood, and the date by which 90% of the pups are in stages 4 or 5. The estimate of the date by which 90% of the pups are in stages 4 or 5 was insensitive to the start date of pupping and varied between 11 and 12 February. This is slightly earlier than predicted by the Normal model, which predicted that 90% of the animals would be beaters by 18 February in 2007, or by February 15 (se=3.0) when all years are pooled.

DISCUSSION

The objective of this work was to estimate the date when 90% of the YOY on Hay Island would reach the beater stage to assist managers and hunters to identify when hunting activities might be undertaken. The decision when to harvest on Hay island will be affected by many factors such as the distribution of births, the proportion of animals still nursing, the proportion of beaters, when animals begin leaving the island and weather. In this study, we considered when animals left the island and were no longer available to hunters. Although it does appear that animals have dispersed by early March, grey seals of all age classes may continue to use Hay Island as a haulout site, but within the context of this study, once beaters begin to disperse they are likely more difficult to harvest.

The Hay Island colony is a relatively new one along the Nova Scotian Eastern Shore. Pup counts are available since 1996, but stage data to determine the temporal distribution of births are limited to three years (2000, 2007, 2008). It is evident that there is inter-annual variability in the distribution of births, which cannot be fully characterized based on the limited data. Staging pups on multiple occasions each year prior to the harvest would improve estimates of the proportion of animals that completely moulted. This would consist of a regular staging survey which involves a minimum of 3 surveys, over time or a single visit to see how the proportion of animals in each stage compares to the progression of births from earlier years. A grey seal pup production survey is planned for January 2010, which will provide an additional estimate.

There is also considerable variability in the duration of lactation, with some studies reporting lactation as short as 14.9 days (se=1.4, n=13)(Baker et al. 1995), and as long as 19 days (Noren et al. 2008) on Sable Island. There is also considerable variability associated with the estimation of the age of the beater stage and when animals begin to enter the water. We used a mean age of 40 days for animals entering the water, but Noren et al (2008) observed that animals as young as 26 days may disperse. The fat composition of the beaters appears to be one factor affecting the timing of when animals disperse, but it accounts for only a small amount of the variance in departure age (Noren et al. 2008).

It is possible to develop a conceptual model to provide guidance on when harvesting might occur. There are several factors to consider. If harvesting activities begin too soon the pupping season may be disrupted, with some abandonment of pups resulting issues relating to humane hunting, economic loss and safety of hunters in the presence of aggressive adult seals. The number of beaters available for harvesting will also be very low limiting economic benefit versus expenses. At the same time, waiting too long will result in animals dispersing from the island

again representing an economic loss. The relationships among these factors are shown in Figure 4. Current data suggest that 90% of the YOY on the island will be beaters during the week of 11-15 February depending on the model used.

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Table 1. Number of animals in each age-dependent morphometric stage on Hay Island,

Date	Newborn	Thin white	Fat-white	Ragged	Beater	Total
2000-01-06	17	51	18	0	0	86
2000-01-19	5	8	82	7	3	105
2000-02-09	0	6	119	176	139	440
2007-01-11	246	879	218	3	0	1346
2007-01-18	58	380	536	25	0	999
2007-01-31	0	28	165	131	37	361
2007-02-01	0	13	161	282	158	614
2007-02-06	0	55	260	536	496	1347
2007-02-10	0	4	126	324	422	876
2008-13-01	13	78	80	8	0	179
2008-24-01	3	21	91	14	1	130
2008-24-01	11	29	119	41	15	215
2008-24-01	2	14	156	56	26	254
2008-7-02	0	8	94	233	322	657

Table 2. Assumed starting date of pupping on Hay Island, the Weibull distribution parameters, the log-likelihood, and the date by which 90% of the pups are in stages 4 or 5.

Start Date	Shape	Rate	Log-likelihood	90% stage 4/5
20/12/06	3.53	25.52	6516.9	02/11/07
21/12/06	3.37	24.47	6505.1	02/11/07
22/12/06	3.21	23.42	6493.1	02/11/07
23/12/06	3.05	22.36	6480.9	02/11/07
24/12/06	2.89	21.29	6468.6	02/11/07
25/12/06	2.72	20.22	6456.4	02/11/07
26/12/06	2.56	19.14	6444.5	02/11/07
27/12/06	2.39	18.05	6433.2	02/12/07
28/12/06	2.22	16.95	6423.2	02/12/07
29/12/06	2.04	15.84	6415.2	02/12/07
30/12/06	1.86	14.73	6410.6	02/12/07
11/12/06	1.67	13.6	6411.8	02/12/07

Table 3. Conversion between days since January 1 and date for a leap year.

Date	Day number	Date	Day number	Date	Day number
Dec 25	25	Jan 22	53	Feb 19	81
Dec 26	26	Jan 23	54	Feb 20	82
Dec 27	27	Jan 24	55	Feb 21	83
Dec 28	28	Jan 25	56	Feb 22	84
Dec 29	29	Jan 26	57	Feb 23	85
Dec 30	30	Jan 27	58	Feb 24	86
Dec 31	31	Jan 28	59	Feb 25	87
Jan 1	32	Jan 29	60	Feb 26	88
Jan 2	33	Jan 30	61	Feb 27	89
Jan 3	34	Jan 31	62	Feb 28	90
Jan 4	35	Feb 1	63	Feb 29	91
Jan 5	36	Feb 2	64	Mar 1	92
Jan 6	37	Feb 3	65	Mar 2	93
Jan 7	38	Feb 4	66	Mar 3	94
Jan 8	39	Feb 5	67	Mar 4	95
Jan 9	40	Feb 6	68	Mar 5	96
Jan 10	41	Feb 7	69		
Jan 11	42	Feb 8	70		
Jan 12	43	Feb 9	71		
Jan 13	44	Feb 10	72		
Jan 14	45	Feb 11	73		
Jan 15	46	Feb 12	74		
Jan 16	47	Feb 13	75		
Jan 17	48	Feb 14	76		
Jan 18	49	Feb 15	77		
Jan 19	50	Feb 16	78		
Jan 20	51	Feb 17	79		
Jan 21	52	Feb 18	80		

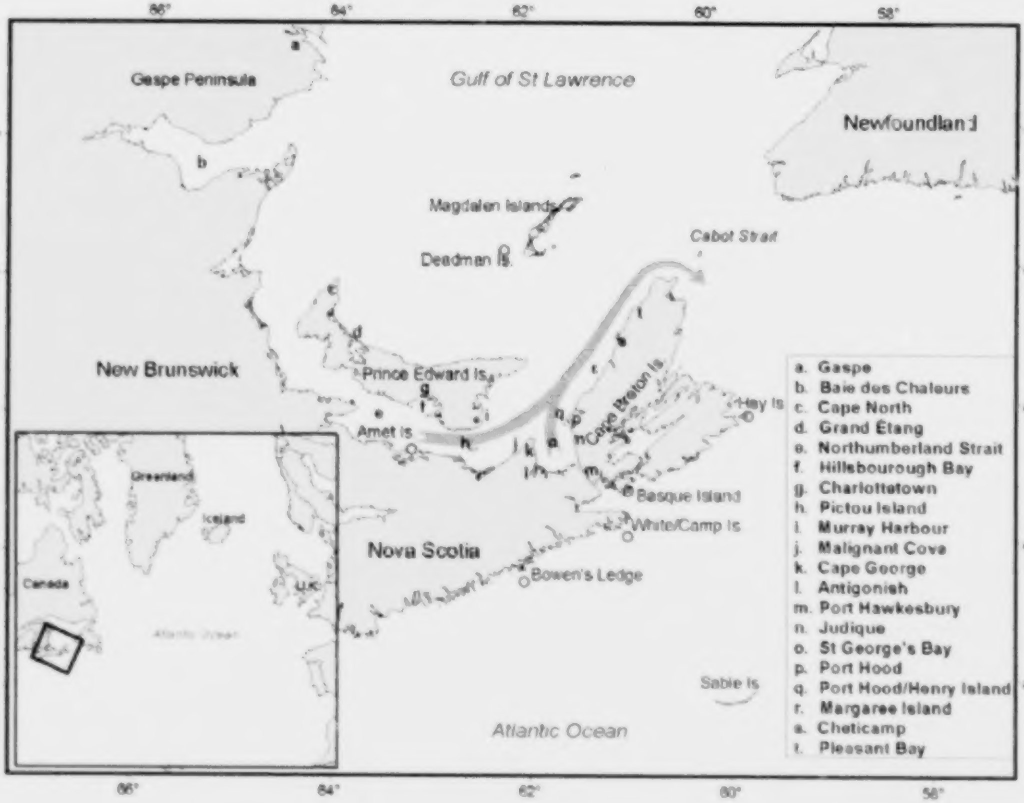
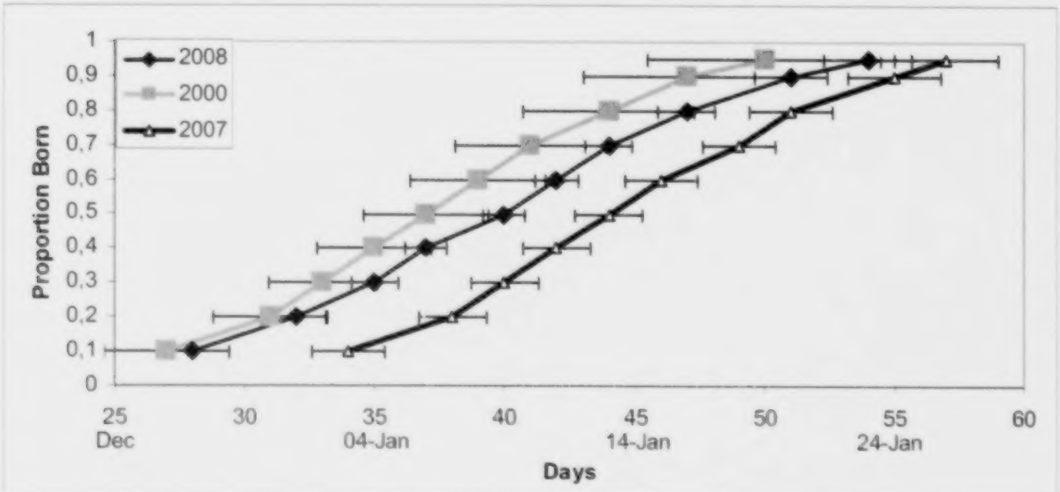


Figure 1. Map of eastern Canada showing locations of man pupping colonies, and direction of ice drift. New colonies on Flat and Noddy Islands are not shown.



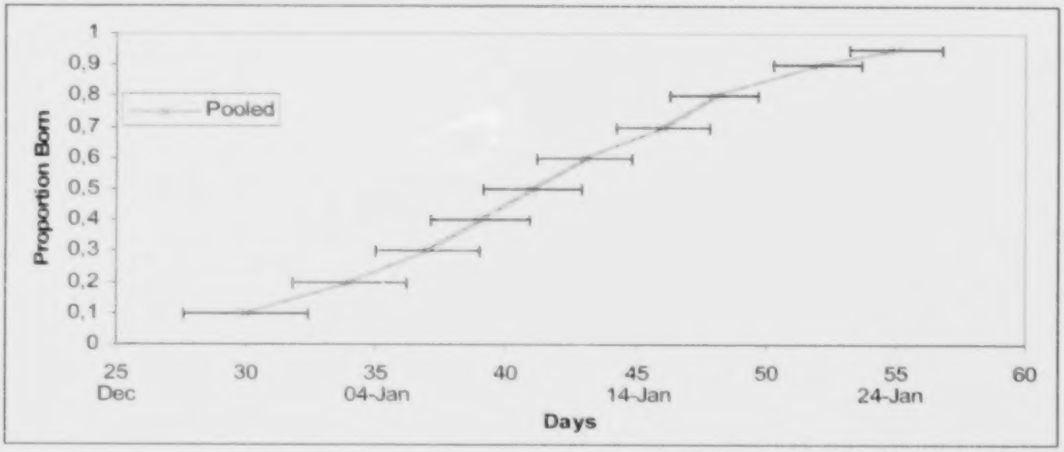
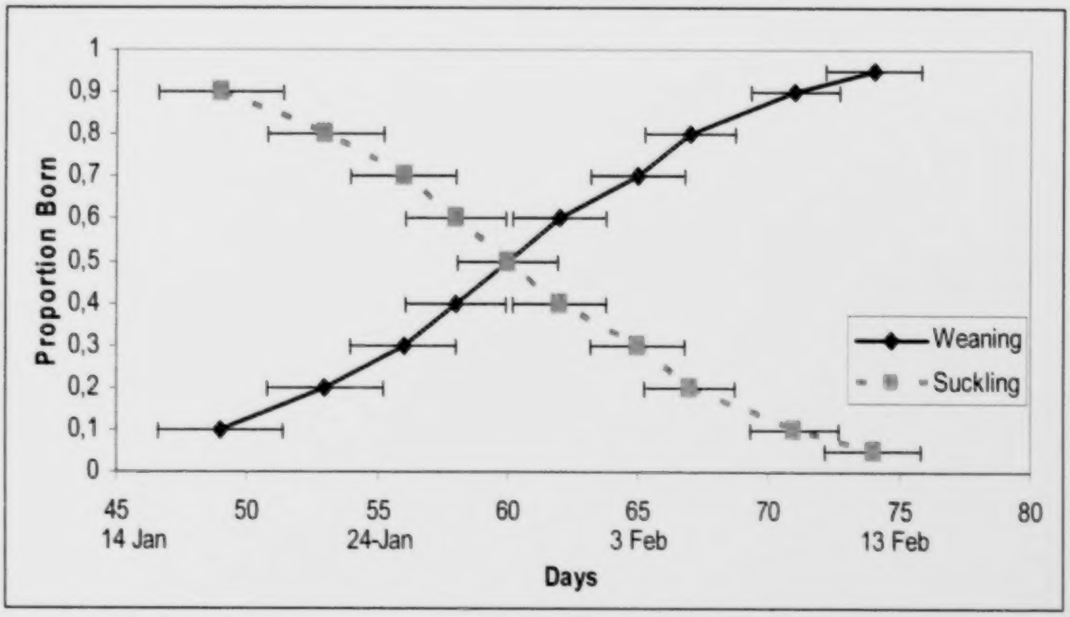


Figure 2. Proportion of births (mean±se) with date on Hay Island in 2000, 2007, 2008, and if all years are combined.



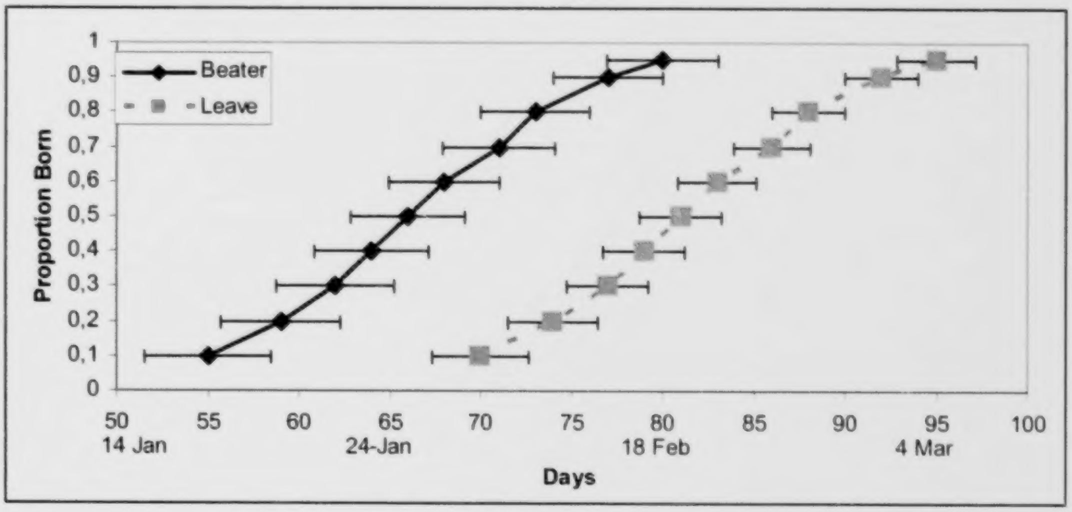


Figure 3. Proportion of animals weaned (mean±se) and proportion suckling (1-proportion weaned) with date on Hay Island, all years pooled.

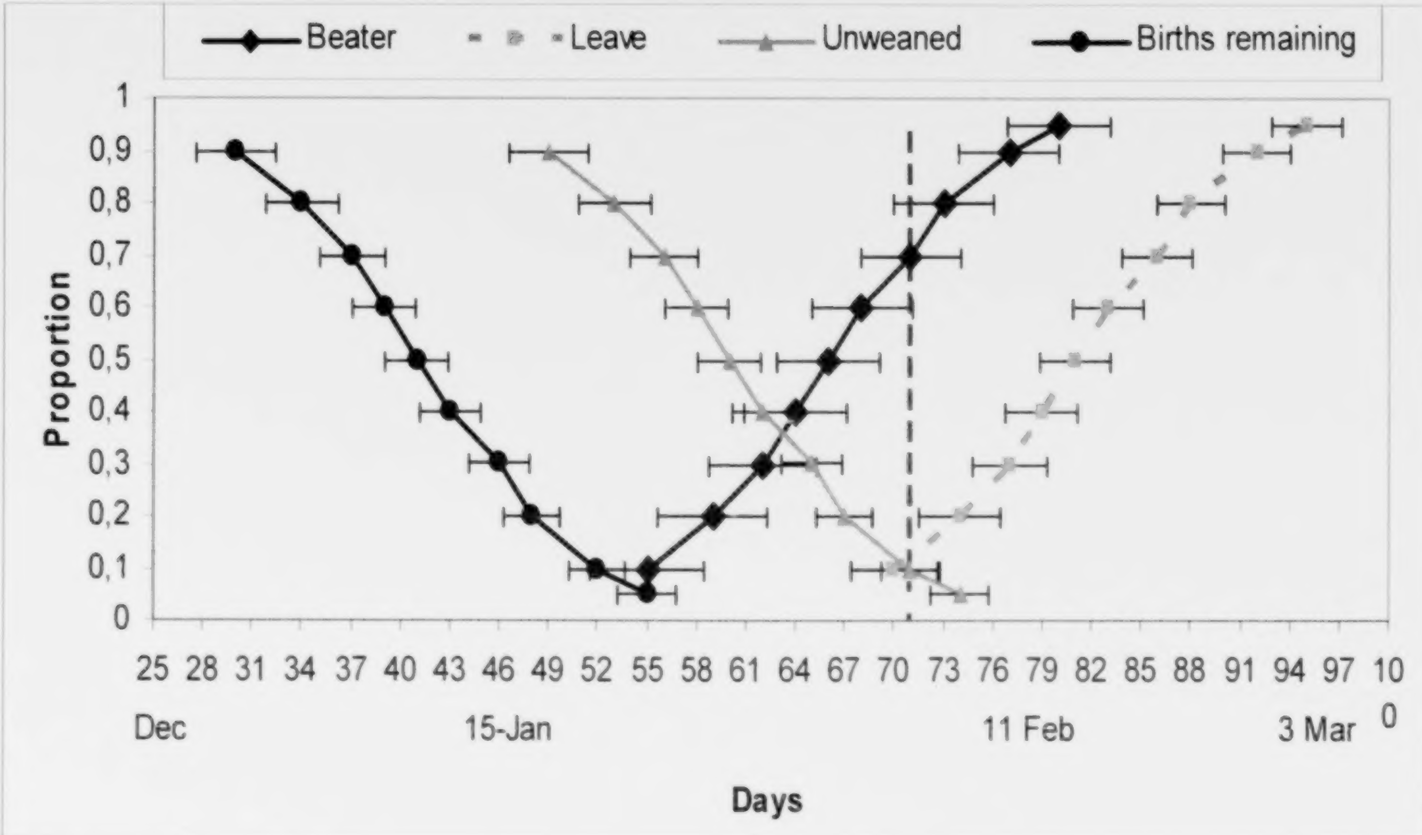


Figure 4. Model outlining the proportion of births remaining, weaned animals, beaters and when animals are expected to leave the island as a function of days since December 1. The vertical dashed line indicates when it is expected that approximately 90% of animals have been weaned, the proportion of beaters is about 55% and the number of animals that have left the island are predicted to be negligible. A conversion from days to date can be found in Table 3.